

Vacant Seat Detection System using Adaboost and Camshift

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Abstract - The objective of this paper is to explain the concept of vacant seat detection and the count of vacant seats in crowded halls using video processing techniques. The idea is achieved using the concept of head shoulder and face detection. Adaboost is used in face and head shoulder detection, in combination with the Camshift to eliminate the susceptibility to noise and light intensity. This work is to identify the vacant seats and then accordingly notify the number of vacant seats for easy crowd management. The continuous update of the number of vacant seats is made, thus making it easy for managing and organizing a huge crowd.

Keywords- Adaboost, Camshift, Head-shoulder detection, Image overlaying, Video surveillance, Person detection, Vacant seat.

I. INTRODUCTION

Vacant seat detection system aims at detecting the presence of vacant seats in a crowded hall [1]. Individual frames obtained from the captured video are analyzed to detect human presence, this data is used to find the number of vacant seats in the hall. In this paper, the Adaboost [2] a boosting algorithm is used to detect the human faces automatically [3], and then the extracted human face is subjected to the Camshift algorithm [4]. It avoids the subjectivity of the artificial selected objects, combines the merits of the two algorithms and forms an efficient and accurate vacant seat detection algorithm. Using the Adaboost algorithm the background of the image is separated. The face detection is performed to check for human presence in a seat. The Camshift algorithm performs RGB to HSV conversion, followed by the head shoulder detection to give the ratio between head and shoulder. The range of the head shoulder ratio obtained is used to confirm human presence in

the seat [5]. The idea of this paper is to extend this algorithm and use them for detecting human presence using the mentioned techniques. The extension helps in identifying if any of the seats within a particular place is vacant or occupied and thus the number of vacant seats in that place could be easily identified [6]. It enhances the speed of organization of people in a place and reduces the unwanted waiting time. The system is used to indicate the number of seats occupied in a hall quickly. It effectively detects the number of empty seats thereby enabling the people outside the hall to know the number of vacant seats available. Thus the system plays a vital role in crowd monitoring and management [7].

II. VACANT SEAT DETECTION SYSTEM

Fig 1 shows what the system exactly does when it is put into action. The captured video is serialized, and then a frame by frame analysis of the video is done. The face detection and head shoulder detection algorithms are used to detect human presence in a seat. Image overlaying methodology is then used to classify the seats. If a human presence is detected, then the vacant seat count is not disturbed, otherwise the count is incremented accordingly.

III. DETAILED METHODOLOGY

A. Introduction

This paper proposes the Adaboost algorithm to detect the human faces automatically and helps in effective facial feature detection. It plays a vital role

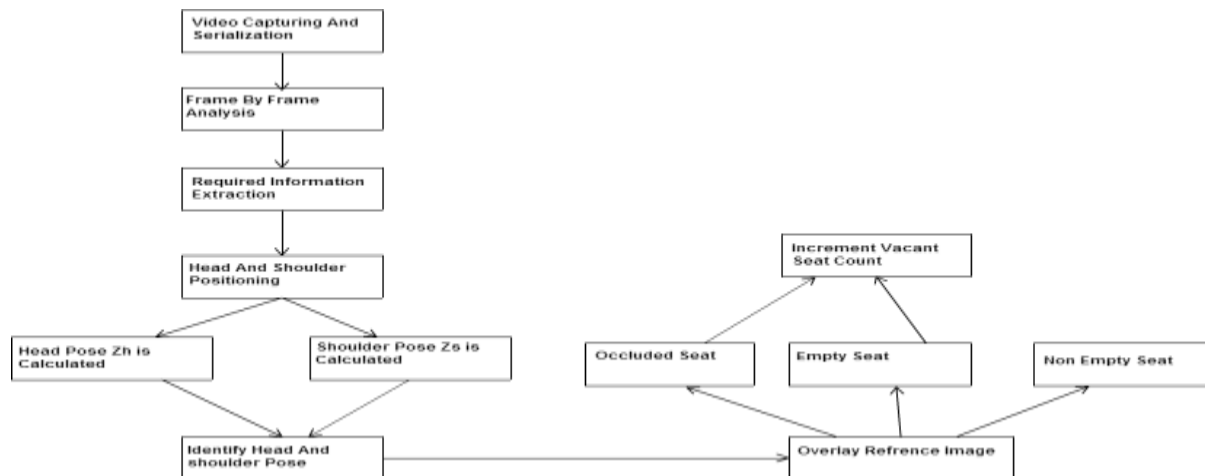


Fig.1. Vacant seat detection system

in fast feature evaluation and training classifiers. Adaboost, short for "Adaptive Boosting", is a Machine learning meta-algorithm. Adaboost is sensitive to noisy data and outliers. The challenges mainly lie in efficient hardware architecture design, since most published vision algorithms do not take into consideration hardware characteristics and parallel processing. Thereby, Adaboost is commonly used in conjunction with other tracking algorithms to improve their performance. Camshift is based on the colour, as because the RGB is sensitive to light intensity changes, in order to reduce the effect of intensity of light changes, Camshift converse the colour space of the image from RGB to HSV [8]. Camshift can be divided into three parts [9]: reverse projection calculation, Mean shift, Camshift implementation. The Camshift algorithm is capable of real-time tracking of objects, not affected by noise, has good robustness and real-time performance is also good. But there are some weaknesses: Trace window must be manually selected, if the face is not appropriate, it will directly affect the results obtained, and may even lead to failures. Therefore, the combination of Adaboost face detection algorithm with the Camshift is used to automatically detect the human faces in the video sequence, and then according to the probability distribution of colour, effective human detection is achieved with Camshift technique [10].

B. Adaptive head shoulder tracking algorithm

In order to track the trajectory of the head, this paper presents Adaboost to detect the human faces first and then uses Camshift technique for the human tracking. Combination of these two techniques ensures

accuracy, speed and can effectively overcome the occlusion as well as interference of skin colour.

Initially, the video is captured and serialised to obtain individual frames. Then, detect the human faces, from the first frame, Adaboost may take the results as: (i) Detect multiple faces; (ii) detect the fault target (non-face). The detected faces are filtered and select samples of the faces are obtained from the sequence successively. Through the above operation, the user can get the desired target area. Since the RGB colour space is sensitive to the light, so we need to convert the target area to HSV colour space, calculate the probability distribution of hue H and then use probability of colour to replace the value of each pixel in the image so we obtain the probability distribution of the colour. This process is called back projection; colour probability distribution is a grayscale image.

C. Detection of the human presence

Adaboost is used to detect the target area through the three fitting functions to model the human body. First obtain the minimum vertical rectangle of the body and extract the human body from the rectangular area, we define the height of the rectangle as h; we use the horizontal line h to capture the body contour from the highest point of the body. As there are a group of people sitting in the hall, we adopt the approach which is based on the contour feature to locate the human head, since the human head is shown as an oval contour. There exists a certain ratio between the human head and shoulder in physical.

Fig-2 and Fig-3 shows the different body postures of the head and shoulder, there are two black dividing lines in the Fig 4 and Fig 5 shown, the first dividing line shows the position of the human head, and the following dividing line indicates the shoulder position. The ratio between these two lines is what confirms that the detected object is human or not and this feature has low complexity. When a person's head showing non-elliptical (such as wear a hat, special hairstyle or other accessories), the method will no longer apply.



Fig.2. Human Body Posture of Head



Fig.3. Human Body Posture of Shoulder

D. Detection of human head

Assuming that the area of human head as F_H , it can be divided into two parts skin region and non-skin region [11]. Using a skin model for the detection of the skin colour pixels in the known human head area of the subjected image, we can detect the skin region and non-skin area. Fig 4 and Fig 5 shows the two images, with the human head showing different poses. If we divide the head area along the centre line into two parts, then when the face or back of the head faces the camera, the grey scale distribution of the two regions are substantially symmetric (Fig 4 shown), and when the face is facing the camera from the left or right, the distribution of the grey scale around the two is obviously different, make F_L , F_R , F_H as the left half of the head skin region, the right half of the skin region and the whole head region respectively, this part of the body pose is defined as

$$Z_h = \begin{cases} 1 & \begin{cases} |F_L - F_R| < \mu \\ \frac{F_L + F_R}{F_H} < 0.5 \end{cases} \\ 0 & \begin{cases} |F_L - F_R| < \mu \\ \frac{F_L + F_R}{F_H} \geq 0.5 \end{cases} \\ \frac{F_L - F_R}{F_H} & |F_L - F_R| \geq \mu \end{cases} \quad (1)$$

Where, μ is a pre-set threshold, when $Z_H=1$ means that the camera focuses the back of head, $Z_H=0$ means that the camera focuses the frontal face, when the $Z_H > 0$, it means that the camera focuses the left side of the head, $Z_H < 0$ means that the camera focuses right side of the head. In Equation (1) when the values of F_L and F_R are closer, it confirms that the head is facing or back to the camera, on this basis, we can calculate the $F_L + F_R F_H$, if $F_L + F_R F_H > 0.5$, it means the skin colour region get the larger proportion of the head, so we determined that the face is facing the camera, otherwise, we determine that the camera is placed at the back of the head; if F_L and F_R is quite different from each other, the judgement can be made as the camera focuses the left or right side of the head. By calculating the value of $F_L - F_R F_H$, the final judgment can be given, if the value is greater than 0, so the camera is placed to the left of the head, if the value is less than 0, means the camera is placed to the right of the head. In order to improve the accuracy, we introduce the orientation angle θ that is used to measure the angle of rotation of the head with respect to the position of the shoulder.



Fig.4. Processed Camshift Image 1

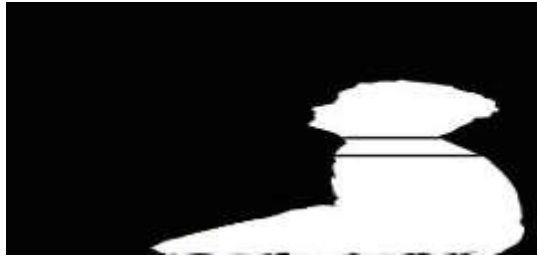


Fig.5. Processed Camshift Image 2

With the help of these two techniques we effectively detect the presence of a human seated in the hall. The above discussed techniques help us to differentiate between the presence of a human or an object present on the seat.

IV. REQUIREMENTS AND DISCUSSION

Segmentation and Detection methods are used in this method for processing the image. 4-5 HD doom cameras are fixed to capture the scenes inside the hall approximately 25x20 ft. in size; these are processed using segmentation and parallel processing techniques to obtain the video as individual frames. For every acquired 1920*1080 image the size of a seat is about 116*100 pixels on an average. A head-shoulder detector is proposed to detect human presence in the seat. This method is chosen for its sensitivity to change in human posture. After the image is subjected to Adaboost and Camshift techniques the image frame is then subjected to the further analysis that includes the concept of Image overlaying. Seats can be divided into three classes according to different appearances: 1) Human occupied seat. 2) Occluded seats are those occluded by people or occupied by bags or clothes. 3) Fully empty seats.

Initially a background model is constructed; a video of this background model is prepared for reference. The reference video has all the seats empty with the same illumination as at the time of the meeting. We obtain the images of the empty seats in various angles and illuminations. In a similar way the processed images of people sitting in the seats at various angles are collected. Segmentation is then applied and a frame by frame comparison of the obtained image and the reference image detects the number of vacant seats. From the actual obtained processed image frame, initially perform an overlay operation of the obtained image to roughly determine the vacant seat position. Only those seats which are actually empty and those which are occluded are taken into consideration and counted as a vacant seat. Once the count is obtained, the number of vacant seats in the

hall is displayed on the monitor held outside the hall. Since the video is processed parallel and continuously the proposed system ensures frequent update of the count of the empty seats in the hall.

V. EXPERIMENTAL RESULTS

The proposed system when implemented using Matlab the results are as follows. Initially, the video is captured, followed by which the frames are obtained from the video and processed individually. For every 5 seconds a frame is obtained and subjected to further processing. One such frame obtained from the video input is shown in the Fig 6.



Fig.6. Sample Image frame



Fig.7. Obtaining frames for individual seats

Now this image is subjected to Adaboost for face detection. First stage in this process is to draw rectangle over individual humans and obtain separate frames for further processing. One of which is shown in Fig 7. Similarly other frames are obtained. The next step in processing is to subject the obtained frames for face and head shoulder detection. When the Fig 7 is processed accordingly, we obtain the output as shown in the Fig 8, the face marked with a 5x3 rectangular box, the shoulder with a 10x5 rectangular box.



Fig.8. Face and Head Shoulder detection output

When all such obtained frames are subjected to similar processing, all the humans present in the Fig 6 are detected and the output of which is shown in the Fig 9, where the humans are marked by a 2x2 rectangular box.



Fig.9. Detection of human presence

Thereby from the Fig 9 we obtain a count of the total number of the humans present. Appropriately we perform a mathematical subtraction between the total count of seats and the number of humans detected and thereby determine the vacant seat count. To make this process more efficient we continue with the image overlaying process, when the initial procedures fail to detect a human presence. Then the Fig 7 will be subjected to a comparison with the reference image, which is an empty seat. Thereby we can distinguish an occluded seat from an empty seat.

VI. CONCLUSION

In this paper, we propose a system that combines the Adaboost and Camshift techniques to track the head and shoulder's movement, and thus by constructing mathematical models to determine the position of the head and shoulders, which has an important application in the video surveillance system. By using the Adaboost face detection and Camshift automatic tracking, the system effectively overcomes

the occlusion that causes tracking failures which ensures reliable tracking of the head and the proposed system has good robustness, timeliness and convenience. Since this is a 2D based method only if the object does not appear severely deformed and occluded, our method can handle it. Thereby, this system effectively finds its application in the field of video surveillance and supports our proposed idea. It could be easily extended for surveillance purposes and seat allotment. It can be used in schools for automatic attendance system. The system plays a major role in surveillance and vacant seat detection in meetings. The system can further be enhanced to point out exactly where the vacant seats are present.

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